

Specification

Encrypted Communication Method

Technical Field

5 The present invention relates to an encrypted communication method and encrypted communication system which execute, on an open network to which many and unspecified nodes are connected, secure communication between a plurality of nodes belonging to a specific
10 group, a node apparatus, and an encrypted communication program.

Background Art

 Conventionally, on an open network (e.g., Internet or public hot spot) to which many and
15 unspecified nodes are connected, various encrypted communication methods are used to encrypt communication between nodes such as nodes, servers, and gateway apparatuses and provide a secure communication path to prevent any third party from peeping the communication
20 contents, as described in, e.g., RFC2401 or RFC3546.

 Encrypted communication protocols to implement an encrypted communication method of this type are roughly classified in the following way depending on the layer to be encrypted.

25 ○ Layer 4 (transport layer) and upper layers
 SSL (Secure Socket Layer), TLS (Transport Layer Security), SSH (Secure Shell)

○ Layer 3 (network layer) and lower layers
IPsec, L2TP (Layer 2 Tunneling Protocol) over
IPsec, Ethernet® over IPsec

In encrypted communication with another node
5 by using these encrypted communication protocols, the
conventional encrypted communication methods can be
classified into the following three types depending on
the forms of communication encryption.

(1) A form to encrypt communication in
10 individual applications such as an Web browser and
e-mail application

(2) A form to encrypt communication by using a
communication encryption module

(3) A form to encrypt communication by using a
15 function provided by the kernel unit of an OS (Operating
System)

The encrypted communication method of form (1)
uses the above-described communication encryption
protocol for layer 4 and upper layers. For example, to
20 encrypt HTTP (Hyper Text Transfer Protocol)
communication with a communication partner having a
domain name "example.com", a URL (Universal Resource
Locator) such as "https://example.com/index.html" is
input in a Web browser to encrypt the HTTP communication
25 with the communication partner by SSL. Such a
communication encryption form cannot be used unless the
application supports the communication encryption

protocol, as a matter of course.

In communication encryption of form (2) using a communication encryption module, the above-described communication encryption protocol for layer 4 and upper
5 layers is mainly used. The communication encryption module operates as an independent process. The communication encryption module intercepts data packets transmitted/received between an application and a communication partner, encrypts/decrypts the packets,
10 and transmits them to the communication partner/application. Examples of the communication encryption module are stunnel that SSL-encrypts an arbitrary TCP (Transport Control Protocol) connection and SSH port forwarding to encryption-tunnel an
15 arbitrary TCP connection by SSH.

The communication encryption method of form (2) can encrypt communication of an arbitrary application because the method can encrypt communication independently of whether an application supports the
20 communication encryption protocol, like the communication encryption method of form (3). This communication encryption form can encrypt communication with consciousness of an application, unlike the communication encryption method of form (3). Hence,
25 only communication of a specific application can be done.

Fig. 10 shows the outline of communication

encryption processing by the communication encryption method of form (2). A communication encryption module A13x includes a communication encryption unit A131x to execute communication encryption processing, and an
5 encrypted communication path setting table A132x in which only a set of the address of a target node (to be referred to as an encrypted communication target node) C1 of encrypted communication and encrypted communication path setting information is registered.
10 The communication encryption module A13x operates as an independent process by itself. To cause the communication encryption module A13x to execute communication encryption processing of a data packet transmitted from an application A11x, the application
15 A11x temporarily transfers the data packet to the communication encryption module A13x to execute necessary encryption processing. After that, the communication encryption module A13x transmits the data packet to the actual communication partner, Hence, the
20 application A11x transmits the data packet by designating the loopback address, i.e., "127.0.0.1" (and the reception port number of the process (communication encryption module) as needed) as the destination address, instead of directly designating the IP address
25 of the actual communication partner, such that the communication encryption module A13x can receive the data packet. Upon receiving the data packet from the

application A11x, the communication encryption module A13x causes an encryption/decryption processing unit A1311x of the communication encryption unit A131x to encrypt the data packet (by using protocol: SSL,
5 encryption algorithm: DES, and digital certificate ID: 11 in Fig. 10) in accordance with encrypted communication path setting information for the preset communication partner (node of IP address "1.2.3.4" in Fig. 10) by looking up the encrypted communication path
10 setting table A132x. Then, the communication encryption module A13x causes an address conversion unit A1312x to rewrite the destination to IP address "1.2.3.4" and transmits the data packet.

The encrypted communication method of form (2)
15 may employ the arrangement with a client node A1x incorporating the communication encryption module A13x, as shown in Fig. 10, or an arrangement in which the communication encryption module is provided as a communication encryption proxy node by an external node.
20 In this case, the application transmits a data packet by designating the IP address of the external node to the destination address. The communication encryption module executes necessary encryption processing for the received data packet and transmits it to a preset
25 communication partner (the IP address of the encrypted communication target node is designated).

In the encrypted communication method of form

(3) which executes communication encryption by using a function provided by the kernel unit of an OS, the above-described communication encryption protocol for layer 3 and lower layers is mainly used. For example, to encrypt all IP packets to a communication partner having an IP address "1.2.3.4", IPsec setting in a transport mode or tunneling mode is done for the communication partner (IP address = 1.2.3.4) in OS setting.

The encrypted communication method of form (3) can encrypt communication of an arbitrary application because the method can encrypt communication independently of whether an application supports the communication encryption protocol, like the encrypted communication method of form (2). However, in the communication encryption form (3), generally, communication with a communication partner having a preset IP address is totally encrypted without consciousness of an application, unlike the encrypted communication method of form (2). Hence, it is therefore impossible to encrypt only communication of a specific application.

Fig. 11 shows the outline of communication encryption processing by the encrypted communication method of form (3). A communication encryption unit A141y to execute communication encryption processing and an encrypted communication path setting table A142y in

which the address of an encrypted communication target node and encrypted communication path setting information are registered are included in a data transmission/reception unit A14y in the kernel unit of an OS. All data packets transmitted from the application A11x are transferred to the data transmission/reception unit A14y for transmission processing. The communication encryption unit A141y in the data transmission/reception unit A14y looks up the encrypted communication path setting table A142y on the basis of the destination address of the data packet. When the destination address is registered as an encrypted communication target node (when the destination address is "1.2.3.4" or "5.6.7.8" in Fig. 11), the data packet is encrypted in accordance with the registered encrypted communication path setting information (protocol: IPsec, encryption algorithm: DES, and digital certificate ID: 11 in Fig. 11) and transmitted to the communication partner.

20 Disclosure of Invention

Problem to be solved by the Invention

The above-described encrypted communication method using a communication encryption function provided by an OS can implement communication encryption independently of whether the application supports the communication encryption protocol. In addition, unlike the above-described encrypted communication method using

a communication encryption module, when a plurality of IP addresses of a partner of encrypted communication (to be referred to as an encrypted communication target node hereinafter) are set in advance, encrypted communication
5 can be done with a plurality of communication partners. However, the cost for setting the encrypted communication target node is high. This problem will be described below in detail.

To execute encrypted communication with a
10 plurality of communication partners on an open network such as the Internet to which many and unspecified nodes are connected, a communication partner serving as an encrypted communication target node must be designated. Identifiers indicating a communication partner on an IP
15 network include a domain name and an IP address (when a partner is designated by a domain name, an IP address corresponding to the domain name must be resolved by a DNS (Domain Name System)). However, because of the following reasons, it is impossible to use these
20 identifiers to designate a communication partner.

○ IP Address

When the number of encrypted communication target nodes is large, the cost of setting is high because it must be done a number of times equal in
25 number to the IP addresses of the communication partner. When an IP address range (also referred to as an IP address scope: e.g., 192.168.1.0/24) is used, settings

of a plurality of encrypted communication target nodes can be integrated. In this case, only encrypted communication target nodes belonging to a common IP address range can be set integrally, as a matter of course. For this reason, it is impossible to form a group of arbitrary encrypted communication target nodes independently of the IP addresses and integrate settings for each group. Additionally, since the IP address of a node may be dynamically changed by a mechanism such as DHCP in general, it is impractical to dynamically change the setting in accordance with a change in IP address of the partner node.

○ Domain Name

If designation can be done by using a domain name, setting need not be changed even when the IP address of an encrypted communication target node is dynamically changed by a mechanism such as DHCP. If designation can be done on the basis of a domain name condition (e.g., domain suffix or domain prefix), a group of arbitrary encrypted communication target nodes can be formed independently of the positions on the network, and settings can be integrated for each group.

The communication encryption unit (A141y in Fig. 11) included in the kernel unit of the OS determines the node type of a communication partner on the basis of information contained in a data packet. However, the data packet transmitted from the

application generally contains no domain name. For this reason, it is impossible in the prior art to use a domain name to designate the partner of encrypted communication. In some cases, the domain name of the communication partner is contained in the datagram or the header field (e.g., Request header of HTTP) of layer 7 of a data packet. Identifying the communication partner on the basis of these pieces of information is impractical because the communication encryption module requires function expansion specialized to individual applications.

It is an object of the present invention to reduce the setting cost of an encrypted communication target node in executing encrypted communication with a plurality of communication partners by using a communication encryption function provided by an OS.

It is another object of the present invention to prevent the number of setting items and the number of setting procedures from depending on the number of encrypted communication target nodes, IP addresses, and the change frequency of nodes included in a group (i.e., to make the setting cost constant) in setting encrypted communication target nodes.

Means of Solution to the Problem

In order to achieve the above-described objects, according to the present invention, there is provided an encrypted communication method characterized

by comprising the steps of:

a) causing a communication method resolution unit to determine on the basis of a domain name contained in one of a name resolution query transmitted
5 from an application that communicates with a node apparatus connected to a network to resolve an IP address of the node apparatus and a name resolution response as a response to the name resolution query whether the node apparatus is an encrypted communication
10 target node;

b) causing an encrypted communication path setting unit to register the IP address of the node apparatus in an encrypted communication path setting table when the node apparatus is the encrypted
15 communication target node;

c) causing a name resolution query/response transmission/reception unit to transmit the IP address of the node apparatus contained in the name resolution response to the application;

20 d) causing the application to transmit a data packet in which the IP address of the node apparatus is set as a destination address; and

e) causing a data transmission/reception unit to receive the data packet transmitted from the
25 application and, if a communication partner IP address set as the destination address of the data packet is registered in the encrypted communication path setting

table, encrypt and transmit the data packet.

According to the present invention, there is provided an encrypted communication method characterized by comprising the steps of:

5 a) causing a communication method resolution unit to determine on the basis of a domain name contained in one of a name resolution query transmitted from an application on a client node to resolve an IP address of another node apparatus serving as a
10 communication target of the application and a name resolution response as a response to the name resolution query whether the other node apparatus is an encrypted communication target node;

 b) causing an encrypted communication path
15 setting unit to register, in an encrypted communication path setting table, a correspondence between the IP address of the other node apparatus and an intercept address that is not used in any other communication session when the other node apparatus is the encrypted
20 communication target node;

 c) causing a name resolution query/response transmission/reception unit to transmit, to the application as the name resolution response, an intercept address corresponding to the IP address of the
25 other node apparatus contained in the name resolution response;

 d) causing the application to transmit a data

packet in which the intercept address is set as a destination address; and

e) causing a data transmission/reception unit to receive the data packet transmitted from the application, read out, from the encrypted communication path setting table, a communication partner IP address corresponding to the intercept address set as the destination address of the data packet, set the readout communication partner IP address as the destination address of the data packet, and encrypt and transmit the set data packet.

According to the present invention, there is provided a node apparatus characterized by comprising an application that communicates with another node apparatus connected to a network, a data transmission/reception unit provided in a kernel unit, and a name resolution proxy unit which relays a name resolution query transmitted from the application to a name resolution server to resolve an IP address of the other node apparatus and a name resolution response as a response to the name resolution query,

the data transmission/reception unit comprising an encrypted communication path setting table which holds a communication partner IP address, and a communication encryption unit which receives a data packet transmitted from the application and encrypts and transmits the data packet when a communication partner

IP address set as the destination address of the data packet is registered in the encrypted communication path setting table, and

the name resolution proxy unit comprising an
5 encrypted communication path setting unit which registers, in the encrypted communication path setting table, the IP address of the other node apparatus resolved by the name resolution response if it is determined on the basis of a domain name of the other
10 node apparatus contained in one of the name resolution query and the name resolution response that the other node apparatus is an encrypted communication target node.

According to the present invention, there is
15 provided a communication encryption node apparatus connected, through a network, to a client node apparatus in which an application that communicates with another node apparatus connected to the network operates, characterized by comprising:

20 a data transmission/reception unit provided in a kernel unit, and a name resolution proxy unit which relays a name resolution query transmitted from the application to a name resolution server to resolve an IP address of the other node apparatus and a name
25 resolution response as a response to the name resolution query,

the data transmission/reception unit

comprising an encrypted communication path setting table which holds a correspondence between a communication partner IP address and an intercept address, and a communication encryption unit which receives a data packet transmitted from the application, reads out, from the encrypted communication path setting table, a communication partner IP address corresponding to an intercept address set as a destination address of the data packet, sets the readout communication partner IP address as the destination address of the data packet, and encrypts and transmits the set data packet, and

the name resolution proxy unit comprising an encrypted communication path setting unit which registers, in the encrypted communication path setting table, a correspondence between the IP address of the other node apparatus resolved by the name resolution response and an intercept address that is not used in any other communication session if it is determined on the basis of a domain name of the other node apparatus contained in one of the name resolution query and the name resolution response that the other node apparatus is an encrypted communication target node, and a name resolution query/response transmission/reception unit which transmits, to the application as the name resolution response, the intercept address corresponding to the IP address of the other node apparatus contained in the name resolution response received from the name

resolution server.

According to the present invention, there is provided an encrypted communication system characterized by comprising a node apparatus in which an application
5 that communicates with another node apparatus connected to a network operates, and a name resolution server which resolves an IP address of each of the node apparatuses,

the node apparatus comprising a data
10 transmission/reception unit provided in a kernel unit, and a name resolution proxy unit which relays a name resolution query transmitted from the application to the name resolution server to resolve the IP address of the other node apparatus and a name resolution response as a
15 response to the name resolution query,

the data transmission/reception unit comprising an encrypted communication path setting table which holds a communication partner IP address, and
a communication encryption unit which receives
20 a data packet transmitted from the application and encrypts and transmits the data packet when a communication partner IP address set as the destination address of the data packet is registered in the encrypted communication path setting table,

25 the name resolution server comprising a communication method resolution unit which determines on the basis of a domain name of the other node apparatus

contained in one of the name resolution query and the
name resolution response whether the other node
apparatus is an encrypted communication target node, and
the name resolution proxy unit comprising an
5 encrypted communication path setting unit which
registers, in the encrypted communication path setting
table, the IP address of the other node apparatus
resolved by the name resolution response if the other
node apparatus is an encrypted communication target
10 node.

According to the present invention, there is
provided an encrypted communication system characterized
by comprising a client node apparatus in which an
application that communicates with another node
15 apparatus connected to a network operates, a
communication encryption node apparatus connected to the
client node apparatus through the network, and a name
resolution server which resolves an IP address of each
of the node apparatuses,

20 the communication encryption node apparatus
comprising a data transmission/reception unit provided
in a kernel unit, and a name resolution proxy unit which
relays a name resolution query transmitted from the
application to the name resolution server to resolve the
25 IP address of the other node apparatus and a name
resolution response as a response to the name resolution
query,

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the data transmission/reception unit
comprising an encrypted communication path setting table
which holds a correspondence between a communication
partner IP address and an intercept address, and a
5 communication encryption unit which receives a data
packet transmitted from the application, reads out, from
the encrypted communication path setting table, a
communication partner IP address corresponding to an
intercept address set as a destination address of the
10 data packet, sets the readout communication partner IP
address as the destination address of the data packet,
and encrypts and transmits the set data packet,

the name resolution server comprising a
communication method resolution unit which determines on
15 the basis of a domain name of the other node apparatus
contained in one of the name resolution query and the
name resolution response whether the other node
apparatus is an encrypted communication target node, and

the name resolution proxy unit comprising an
20 encrypted communication path setting unit which
registers, in the encrypted communication path setting
table, a correspondence between the IP address of the
other node apparatus resolved by the name resolution
response and an intercept address that is not used in
25 any other communication session if the other node
apparatus is an encrypted communication target node, and
a name resolution query/response transmission/reception

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unit which transmits, to the application as the name
resolution response, the intercept address corresponding
to the IP address of the other node apparatus contained
in the name resolution response received from the name
5 resolution server.

According to the present invention, there is
provided a program which causes a computer included in a
node apparatus in which an application that communicates
with another node apparatus connected to a network
10 operates to function as communication encryption means
provided in a data transmission/reception unit of a
kernel unit, and name resolution proxy means for
relaying a name resolution query transmitted from the
application to a name resolution server to resolve an IP
15 address of the other node apparatus and a name
resolution response as a response to the name resolution
query, characterized in that

the communication encryption means receives a
data packet transmitted from the application and
20 encrypts and transmits the data packet when a
communication partner IP address set as the destination
address of the data packet is registered in an encrypted
communication path setting table that holds a
communication partner IP address, and

25 the name resolution proxy means comprises
encrypted communication path setting means for
registering, in the encrypted communication path setting

table, the IP address of the other node apparatus
resolved by the name resolution response if it is
determined on the basis of a domain name of the other
node apparatus contained in one of the name resolution
5 query and the name resolution response that the other
node apparatus is an encrypted communication target
node.

According to the present invention, there is
provided a program which causes a computer included in a
10 communication encryption node apparatus connected,
through a network, to a client node apparatus in which
an application that communicates with another node
apparatus connected to the network operates to function
as communication encryption means provided in a data
15 transmission/reception unit of a kernel unit, and name
resolution proxy means for relaying a name resolution
query transmitted from the application to a name
resolution server to resolve an IP address of the other
node apparatus and a name resolution response as a
20 response to the name resolution query, characterized in
that

the communication encryption means receives a
data packet transmitted from the application, reads out,
from an encrypted communication path setting table that
25 holds a correspondence between a communication partner
IP address and an intercept address, a communication
partner IP address corresponding to an intercept address

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set as a destination address of the data packet, sets
the readout communication partner IP address as the
destination address of the data packet, and encrypts and
transmits the set data packet, and

5 the name resolution proxy means comprises
encrypted communication path setting means for
registering, in the encrypted communication path setting
table, a correspondence between the IP address of the
other node apparatus resolved by the name resolution
10 response and an intercept address that is not used in
any other communication session if it is determined on
the basis of a domain name of the other node apparatus
contained in one of the name resolution query and the
name resolution response that the other node apparatus
15 is an encrypted communication target node, and name
resolution query/response transmission/reception means
for transmitting, to the application as the name
resolution response, the intercept address corresponding
to the IP address of the other node apparatus contained
20 in the name resolution response received from the name
resolution server.

Effects of the Invention

According to the present invention, the
setting cost of an encrypted communication target node
25 in executing encrypted communication with a plurality of
communication partners by using a communication
encryption function provided by an OS can be reduced.

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This is because the node type of the communication partner is determined on the basis of a domain name contained in a name resolution query transmitted from an application to resolve the IP address of the
5 communication partner or a name resolution response as a response to the name resolution query.

Brief Description of Drawings

Fig. 1 is a block diagram showing the arrangement of the first embodiment of the present
10 invention;

Fig. 2 is a view showing an example of a CUG setting table according to the first embodiment of the present invention;

Fig. 3 is a view showing an example of an
15 encrypted communication path setting table according to the first embodiment of the present invention;

Fig. 4 is a flowchart showing the operation of a DNS Proxy unit according to the first and third embodiments of the present invention upon receiving a
20 name resolution request;

Fig. 5 is a block diagram showing the arrangement of the second embodiment of the present invention;

Fig. 6 is a view showing an example of a CUG
25 setting database according to the second embodiment of the present invention;

Fig. 7 is a block diagram showing the

arrangement of the third embodiment of the present invention;

Fig. 8 is a view showing an example of an encrypted communication path setting table according to the third embodiment of the present invention;

Fig. 9 is a block diagram showing the arrangement of a client node according to a modification to the third embodiment of the present invention;

Fig. 10 is a view showing the arrangement of a conventional encrypted communication system using a communication encryption module; and

Fig. 11 is a view showing the arrangement of a conventional encrypted communication system using the communication encryption function of the kernel unit of an OS.

Best Mode for Carrying Out the Invention

The first embodiment of the present invention will be described next in detail with reference to the accompanying drawings.

Referring to Fig. 1, the first embodiment of the present invention is implemented by a client node Ala, DNS (Domain Name System) server Bla, encrypted communication target node C1, and normal communication target node D1. The client node Ala, DNS server Bla, encrypted communication target node C1, and normal communication target node D1 are connected through a network E1. The encrypted communication target node C1

executes encrypted communication with the client node Ala. The normal communication target node D1 executes normal communication without encryption with the client node Ala.

5 The client node Ala includes an application A11x, DNS Proxy unit A12a, and data transmission/reception unit A14a. The data transmission/reception unit A14a is provided in the kernel unit to transmit/receive a data packet.

10 The application A11x is software such as a Web browser, e-mail software, or video conference software to implement its purpose by using a computer. The application A11x has a function of requesting to resolve the name of a communication partner to an IP address.

15 In the scope of this specification, "name" indicates all identifiers directly or indirectly corresponding to one or a plurality of IP addresses or an IP address scope (more specifically, when a "name" is given, one or a plurality of IP addresses or an IP
20 address scope can be specified directly or indirectly: a "name" need not always be specified from an IP address or IP address scope).

For example, the "name" includes the following identifiers.

- 25 • Identifier A having a correspondence of A
↔ 1.2.3.4 ("1.2.3.4" is an example of an IP address)
• Identifier B having a correspondence of

1.2.3.0/24 ("1.2.3.0/24" is an example of an IP address scope)

- Identifier C having correspondences of $C \leftarrow \rightarrow 1.2.3.4$ and $C \longleftrightarrow 5.6.7.8$

5 • Identifier D having a correspondence of $D \longleftrightarrow A$

A typical example of the name currently used in the Internet is a domain name (e.g., "sato.biglobe.ne.jp" or "suzuki.nec.com": the domain name is also called FQDN (Fully Qualified Domain Name)).

Specifying one or a plurality of IP addresses or an IP address scope corresponding to a name on the basis of the name is generally called name resolution. A typical mechanism of name resolution is a DNS. When a DNS is used, a domain name can be resolved to an IP address. Other examples of the name resolution mechanism are NIS (Network Information Service) and WINS (Windows® Internet Name Service). In this specification, "name resolution" is not limited to the above-described examples and is used as a term to indicate "specifying one or a plurality of IP addresses or an IP address scope corresponding to a name on the basis of the name" (for example, the name resolution mechanism also includes a Web server with a CGI (Common Gateway Interface) that receives a character string and displays an IP address corresponding to it).

For the descriptive convenience, a domain name

and DNS will be exemplified as a name and name resolution mechanism, respectively. However, the following explanation can be applied to any name and name resolution mechanism. In application, a domain name and DNS are replaced with a name and name resolution, respectively (e.g., DNS server → name resolution server, DNS query message → name resolution query message, and DNS response message → name resolution response message).

10 In this embodiment, the application A11x requests resolution of domain name of communication partner → IP address by transmitting a DNS query message to the loopback address (e.g., "127.0.0.1") assigned to the DNS Proxy unit A12a. Hence, the DNS
15 query message transmitted from the application A11x is received by the DNS Proxy unit A12a. A loopback address is an IP address used for closed communication in a node and generally corresponds to an IP address within a scope of "127.0.0.0/8".

20 The application A11x designates an IP address contained in the name resolution result of the DNS response message received from the DNS Proxy unit A12a to the destination address of a transmission data packet and transmits the data.

25 Generally, the function of receiving a name resolution request from the application and creating/transmitting a DNS query message and the

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function of acquiring a name resolution result from a
DNS response message received from the DNS server and
transferring the name resolution result to the
application are provided as a system function of the
5 fundamental software (also referred to as an OS
(Operating System)) of the node. In this specification,
these functions will be expressed as "causing an
application to transmit/receive a DNS message" for the
descriptive convenience, including the above-described
10 expressions.

The DNS Proxy unit A12a includes a DNS
query/response transmission/reception unit A121a,
communication method resolution unit A122a, encrypted
communication path setting unit A123a, DNS server
15 address setting table A124a, and CUG (Closed User Group)
setting table A125a.

The DNS Proxy unit A12a has a function of,
upon receiving a name resolution request from the
application A11x, causing the DNS server B1a to resolve
20 the IP address of the communication partner of the
application A11x, determining the node type of the
communication partner (the node type of a communication
partner indicates whether a communication partner is an
encrypted communication target node or a target node of
25 normal communication (to be referred to as a normal
communication target node hereinafter)), if the
communication partner is an encrypted communication

target node, registering the IP address of the encrypted communication target node in an encrypted communication path setting table A142a provided in the data transmission/reception unit A14a. If the communication partner is a normal communication target node, registration is not executed.

The arrangement of the DNS Proxy unit A12a will be described below. The DNS query/response transmission/reception unit A121a will be described first.

Upon receiving a DNS query message from the application A11x, the DNS query/response transmission/reception unit A121a transmits the DNS query message to the external DNS server B1a registered in the DNS server address setting table A124a. Upon receiving a DNS response message from the external DNS server B1a as the response to the DNS query message, the DNS query/response transmission/reception unit A121a transfers a name resolution result contained in the DNS response message to the communication method resolution unit A122a. The name resolution result transferred to the communication method resolution unit A122a contains the domain name (i.e., the domain name of the communication partner of the application A11x) as the target of name resolution and the resolved IP address (i.e., the IP address of the communication partner). The DNS query/response transmission/reception unit A121a

transfers the name resolution result to the communication method resolution unit A122a and transmits the DNS response message to the application A11x.

The communication method resolution unit A122a will be described next. The communication method resolution unit A122a determines the node type of the communication partner of the application A11x by looking up the CUG setting table A125a on the basis of the name resolution result received from the DNS query/response transmission/reception unit A121a. If the communication partner of the application A11x is an encrypted communication target node, the communication method resolution unit A122a grasps the setting information of an encrypted communication path to be used for communication of the communication partner by looking up the CUG setting table A125a.

The communication method resolution unit A122a uses a domain name as a communication partner identifier to determine the node type. In determining the node type of the communication partner of the application A11x by using a domain name, the communication method resolution unit A122a checks whether the domain name of the communication partner is wholly or partially registered in the CUG setting table A125a as the domain name of the encrypted communication target node. For example, assume that the domain name of the communication partner is "sato.biglobe.ne.jp". In this

case, the communication method resolution unit A122a checks whether the domain name "sato.biglobe.ne.jp" or a domain name condition that matches "sato.biglobe.ne.jp" (e.g., a domain prefix such as "sato.*" (indicating a domain name with a fore label "sato"), a domain suffix such as ".*biglobe.ne.jp" (indicating a domain name with a rear label "biglobe.ne.jp"), or an arbitrary domain name condition such as ".*biglobe.*" (indicating an arbitrary domain name including a label "biglobe")) is registered in the CUG setting table A125a as the domain name of the encrypted communication target node.

The communication method resolution unit A122a determines the node type of the communication partner of the application A11x by the above-described method. Upon determining that the node type is an encrypted communication target node, the communication method resolution unit A122a transfers, to the encrypted communication path setting unit A123a, the name resolution result received from the DNS query/response transmission/reception unit A121a and encrypted communication path setting information to be used for communication with the communication partner.

The encrypted communication path setting unit A123a will be described next. The encrypted communication path setting unit A123a has a function of registering, in the encrypted communication path setting table A142a included in the data transmission/reception

unit A14a, the IP address of the encrypted communication target node and encrypted communication path setting information to be used for communication with the encrypted communication target node. More specifically, 5 the encrypted communication path setting unit A123a registers, in the encrypted communication path setting table A142a, the IP address of the communication partner contained in the name resolution result of the communication partner of the application A11x received 10 from the communication method resolution unit A122a and encrypted communication path setting information to be used for communication with the communication partner.

The DNS server address setting table A124a will be described next. The address of the external DNS 15 server B1a is registered in the DNS server address setting table A124a. The DNS server address setting table A124a is looked up by the DNS query/response transmission/reception unit A121a in transmitting a DNS query message.

20 The CUG setting table A125a will be described next. Information about a CUG (Closed User Group) in which the client node A1 participates is registered in the CUG setting table A125a. A CUG indicates a group including two or more specific nodes. Communication in 25 the group is encrypted so that any third party outside the group cannot peep it. That is, any other node in the CUG including the client node A1a as a participant

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serves as an encrypted communication target node for the client node Ala. The CUG setting table A125a is looked up by the communication method resolution unit A122a to determine the node type of the communication partner of the application A11x. More specifically, the identification information of each node (i.e., encrypted communication target node) in the CUG including the client node Ala as a participant is registered in the CUG setting table A125a. The identification information of a node registered in the CUG setting table A125a is a domain name condition. For example, when "*.myfriends.com" is registered, a communication partner having a domain name (e.g., "sato.myfriends.com") matching "*.myfriends.com" is an encrypted communication target node.

The setting information of an encrypted communication path to be used for communication with a node in the CUG can also be registered in the CUG setting table A125a, although this registration information is not essential. Detailed examples of the encrypted communication path setting information are a communication protocol (e.g., IPsec, SSL (Secure Socket Layer), or TLS (Transport Layer Security)), digital certificate ID (a digital certificate is an electronic certificate to prove self presence and includes, e.g., X.509 of ITU-T (International Telecommunication Union-Telecommunication Standardization Sector)

recommendation: in this description, a digital
certificate ID indicates an identifier to be used to
select a digital certificate to be used by the
application Allx in a session), and an encryption
5 algorithm (e.g., DES (Data Encryption Standard), 3DES
(triple-DES), or AES (Advanced Encryption Standard)).

Fig. 2 shows an example of the CUG setting
table A125a. In a CUG setting table 201 shown in
Fig. 2, domain name conditions are registered as
10 encrypted communication target node identification
information, and communication protocols, digital
certificate IDs, and encryption algorithms are
registered as encrypted communication path setting
information. For example, the fourth entry of the CUG
15 setting table 201 shown in Fig. 2 is set such that
communication partner nodes (e.g., yamada.myfriends.com
and sato.myfriends.com) having domain names matching a
domain name condition "*.myfriends.com" are encrypted
communication target nodes, and encrypted communication
20 with those nodes is executed by using a communication
protocol: SSL, digital certificate ID: 11, and
encryption algorithm: DES.

When the DNS Proxy unit A12a has the table 201
shown in Fig. 2 as the CUG setting table A125a, the
25 communication method resolution unit A122a determines
the node type of the communication partner by using the
domain name of the communication partner. For example,

assume that the domain name of the communication partner is "taro.nec.co.jp". This domain name is registered in the second entry of the table 201. For this reason, the communication method resolution unit A122a determines
5 that the communication partner is an encrypted communication target node. Assume that the domain name of the communication partner is "yamada.myfriends.com". The domain name itself is not registered in the table 201. However, since the domain suffix ":myfriends.com"
10 is registered in the fourth entry of the table 201, the communication method resolution unit A122a determines even in this case that the communication partner is an encrypted communication target node. If the domain name of the communication partner does not match any of the
15 domain names registered in the table 201, the communication method resolution unit A122a determines that the communication partner is a normal communication target node.

The arrangement of the DNS Proxy unit A12a has
20 been described above.

The data transmission/reception unit A14a will be described next. The data transmission/reception unit A14a includes a communication encryption unit A141a and encrypted communication path setting table A142a. All
25 data packets transmitted from the application A11x to external nodes are intercepted by the data transmission/reception unit A14a and subjected to

transmission processing.

The communication encryption unit A141a has an encryption/decryption processing unit A1411a that encrypts/decrypts a data packet. The

5 encryption/decryption processing unit A1411a has a function of looking up the encrypted communication path setting table A142a on the basis of the destination IP address of a data packet received from the application A11x and encrypting the received data packet in
10 accordance with encrypted communication path setting information registered in the table. The encryption/decryption processing unit A1411a also has a function of looking up the encrypted communication path setting table A142a on the basis of the transmission
15 source address of a data packet received from an external communication partner node and decrypting the received data packet in accordance with encrypted communication path setting information registered in the table.

20 The encrypted communication path setting table A142a will be described next. The IP address of an encrypted communication target node and encrypted communication path setting information to be used for communication with the encrypted communication target
25 node are registered in the encrypted communication path setting table A142a. Registration is dynamically done by the encrypted communication path setting unit A123a.

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A table 301 shown in Fig. 3 indicates an example of the encrypted communication path setting table A142a. In this example, communication partner IP addresses and encrypted communication path setting information, i.e., communication protocols, digital certificate IDs, and encryption algorithms are registered.

Assume that the data transmission/reception unit A14a holds the table 301 shown in Fig. 3 as the encrypted communication path setting table A142a. A case will be described in which the data transmission/reception unit A14a intercepts a data packet with a destination address "133.11.64.24". When the data transmission/reception unit A14a intercepts a data packet, the communication encryption unit A141a looks up the encrypted communication path setting table A142a. In this case, the second entry of the encrypted communication path setting table A142a corresponds to the intercepted data packet. The communication encryption unit A141a encrypts the data packet in accordance with the setting information (communication protocol: IPsec, digital certificate ID: 10, encryption algorithm: 3DES) registered in the second entry and transmits the data packet.

The arrangement of the data transmission/reception unit A14a has been described above.

The DNS server B1a will be described next.

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The DNS server B1a executes name resolution requested by a DNS query message and returns a resolution result to the request source by a DNS response message. The DNS server B1a includes a DNS response/query

5 transmission/reception unit B11a, name resolution unit B12a, and address resolution database B13a. These components have the following functions.

The DNS response/query transmission/reception unit B11a receives a DNS query message from the client
10 node A1a and transfers a name resolution request contained in the message to the name resolution unit B12a. The DNS response/query transmission/reception unit B11a also sends a name resolution result received from the name resolution unit B12a to the client node A1
15 by a DNS response message.

The name resolution unit B12a executes resolution processing for a name resolution request received from the DNS response/query transmission/reception unit B11a by looking up the
20 address resolution database B13a and transfers a name resolution result to the DNS response/query transmission/reception unit B11a.

Domain names and corresponding IP addresses are registered in the address resolution database B13a.

25 The operation of the client node A1a when the application A11x communicates with the encrypted communication target node C1 or normal communication

target node D1 in this embodiment will be described next in detail.

Operations of the client node A1a are roughly classified into an operation executed when the
5 application A11x issues a name resolution request for the domain name of a communication partner and an operation executed when a data packet is transmitted to the communication partner.

The operation of the client node A1a when the
10 application A11x issues a name resolution request will be described first.

The application A11x requests name resolution of a communication partner by transmitting a DNS query message to a loopback address (e.g., "127.1.1.1"). The
15 DNS query message transmitted from the application A11x is received by the DNS Proxy unit A12a (more specifically, the DNS query/response transmission/reception unit A121a in the DNS Proxy unit A12a). Subsequent processing is executed in the DNS
20 Proxy unit A12a.

The operation of the DNS Proxy unit A12a upon receiving a DNS query message from the application A11x will be described with reference to Fig. 4.

Upon receiving a DNS query message from the
25 application A11x (step S101), the DNS query/response transmission/reception unit A121a transfers the received DNS query message to the external DNS server B1a

registered in the DNS server address setting table A124a (step S102) and receives a DNS response message from the DNS server B1a as a response (step S103).

The DNS query/response transmission/reception unit A121a extracts a name resolution result from the received DNS response message and transfers the name resolution result to the communication method resolution unit A122a. The communication method resolution unit A122a determines the type (encrypted communication target node or normal communication target node) of the communication partner by looking up the CUG setting table A125a on the basis of the received name resolution result (step S104). If the communication partner is an encrypted communication target node, the communication method resolution unit A122a grasps encrypted communication path setting information registered in the CUG setting table A125a.

When the communication partner is an encrypted communication target node, the communication method resolution unit A122a transfers, to the encrypted communication path setting unit A123a, the name resolution result received from the DNS query/response transmission/reception unit A121a and encrypted communication path setting information acquired from the CUG setting table A125a. Upon receiving the name resolution result and encrypted communication path setting information from the communication method

resolution unit A122a, the encrypted communication path
setting unit A123a registers these pieces of information
in the encrypted communication path setting table A142a
(S105). After registration, the DNS query/response
5 transmission/reception unit A121a transmits, to the
application A11x, a DNS response message containing the
name resolution result received from the external DNS
server B1a (S106).

The operation of the client node A1 when the
10 application A11x issues a name resolution request has
been described above.

The operation when the application A11x
transmits a data packet to a communication partner will
be described next.

15 Upon receiving a DNS response message from the
DNS Proxy unit A12a, the application A11x transmits a
data packet to an IP address (i.e., the IP address of
the communication partner) contained in the name
resolution result given by the DNS response message.
20 All transmitted data packets are intercepted by the data
transmission/reception unit A14a.

When the data transmission/reception unit A14a
intercepts the data packet, the communication encryption
unit A141a looks up the encrypted communication path
25 setting table A142a on the basis of the destination IP
address of the received data packet and checks whether
the destination IP address is registered in the IP

address of the encrypted communication target node.

When the node is an encrypted communication target node,
the data packet is encrypted and transmitted. When the
node is a normal communication target node, the data
5 packet is directly transmitted.

In the above description, the node type of the
communication partner is determined after the DNS Proxy
unit A12a receives the name resolution result of the
communication partner from the external DNS server Bla.

10 In this embodiment, as another method, the node type of
the communication partner may be determined before the
DNS Proxy unit A12a requests the external DNS server Bla
to execute name resolution of the communication partner.
In this case, control can be done such that, e.g., the
15 DNS server to receive the name resolution request (i.e.,
receive a DNS query message) changes depending on the
node type of the communication partner. Hence, a DNS
server dedicated to an encrypted communication group can
be formed.

20 The effects of this embodiment will be
described below.

In the prior art, when the kernel unit of the
OS executes communication encryption, as in this
embodiment, the node type of the communication partner
25 is determined on the basis of information contained in a
data packet. Hence, the identification information of
the encrypted communication target node cannot be

designated by using a domain name. In this embodiment, however, the DNS Proxy unit A12a intercepts a DNS message exchanged between the DNS server B1a and the application A11x in requesting name resolution of the communication partner and determines the node type of the communication partner on the basis of information contained in the DNS message. Hence, the identification information of the encrypted communication target node can be designated by using a domain name. When identification information is designated by a domain name, setting need not be changed even when the IP address of the communication partner dynamically changes (e.g., when the IP address is assigned by DHCP), unlike a case wherein designation is done by using an IP address. In addition, an encrypted communication target node can also be designated by a domain name condition (e.g., a domain prefix such as "sato.*" (indicating an FQDN with front label "sato"), a domain suffix such as "*.biglobe.ne.jp" (indicating an FQDN with a back label "biglobe.ne.jp"), or a condition such as "*.biglobe.*" (indicating an arbitrary FQDN including a label "biglobe")). When communication is to be executed by using an encrypted communication path with setting common to a plurality of nodes included in a group, the setting can be done for each group by using a domain name condition common to nodes included in each group (e.g., defining the domain suffix of nodes in a group as

"*.myfriends.com"). Hence, the setting cost can be reduced. If setting is to be done simply for each group, an IP address scope such as "10.2.1.0/24" can also be used. However, if the IP addresses of nodes
5 included in a group do not belong to the same IP address scope, the IP address scope cannot be used as the identification information of the group, and it is impossible to freely form a group including arbitrary nodes.

10 To the contrary, a domain name can freely be added independently of the IP address. Hence, a group can freely be formed.

The second embodiment of the present invention will be described next in detail with reference to the
15 accompanying drawings.

Referring to Fig. 5, the second embodiment of the present invention is different from the first embodiment of the present invention in that a communication method resolution unit and a CUG setting
20 table are included not in a DNS Proxy unit A12d but in a DNS server B1d. In this embodiment, the node type of the communication partner of an application A11x and encrypted communication path setting information to be used when the communication partner is an encrypted
25 communication target node are resolved not in a client node A1d but by the external DNS server B1d.

The second embodiment will be described below

with the focus on different points from the first embodiment of the present invention (i.e., the DNS Proxy unit A12d and DNS server B1d).

The DNS Proxy unit A12d will be described first. In this embodiment, the DNS Proxy unit A12d has a function of requesting the DNS server B1d to execute name resolution of the communication partner of the application A11x and resolve the node type of the communication partner (and if the communication partner is an encrypted communication target node, encrypted communication path setting information to be used for communication with the communication partner), and if the communication partner is an encrypted communication target node, registering the encrypted communication path setting information resolved by the DNS server B1d in an encrypted communication path setting table A142a.

In addition to a function of requesting the external DNS server B1d to execute name resolution of the communication partner of the application A11x, a DNS query/response transmission/reception unit A121d has a function of requesting the external DNS server B1d to resolve the node type of the communication partner of the application A11x and, if the communication partner is an encrypted communication target node, encrypted communication path setting information to be used for communication with the communication partner. Upon receiving a DNS query message, the DNS query/response

transmission/reception unit A121d transfers the message to the DNS server B1d and executes reception processing of a DNS response message received as a response. The DNS response message received from the DNS server B1d contains the node type information of the communication partner in addition to the name resolution result of the communication partner of the application A11x. If the communication partner is an encrypted communication target node, the DNS response message also contains encrypted communication path setting information to be used for communication with the communication partner.

When the DNS response message indicates that the communication partner is a normal communication target node and an encrypted communication target node, the DNS query/response transmission/reception unit A121d notifies, by the DNS response message, the application A11x of the name resolution result of the communication partner contained in the received message. When the DNS response message indicates that the communication partner is an encrypted communication target node, the DNS query/response transmission/reception unit A121d transfers, to an encrypted communication path setting unit A123d, the name resolution result of the communication partner and the encrypted communication path setting information to be used for communication with the communication partner. The encrypted communication path setting unit A123d has the same

functions as those of the encrypted communication unit A123a of the first embodiment of the present invention and registers information received from the DNS query/response transmission/reception unit A121d in the encrypted communication path setting table A142a.

The address of the external DNS server B1d is registered in a DNS server address setting table A124a.

The arrangement of the DNS Proxy unit A12d has been described above.

The DNS server B1d will be described next. In addition of a name resolution function provided in a normal DNS server, the DNS server B1d has a function of resolving the type of a node as the target of a name resolution request and, if the node is an encrypted communication target node, a function of resolving encrypted communication path setting information to be used for communication with the node.

The DNS server B1d includes a DNS response/query transmission/reception unit B11d, name resolution unit B12a, address resolution database B13a, communication method resolution unit B14d, and CUG setting database B15d. Each unit will be described below.

The DNS response/query transmission/reception unit B11d transfers a name resolution request (more specifically, the domain name of the name resolution target contained in the received DNS query message or

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the identifier (e.g., the IP address or domain name) of the client node A1d) received from the client node A1d to the name resolution unit B12a and receives a name resolution result (more specifically, the IP address of the resolution result is contained in addition to information contained in the name resolution request) from the name resolution unit B12a. The DNS response/query transmission/reception unit B11d transfers the name resolution result to the communication method resolution unit B14d and receives the type information of the name resolution request target node from the communication method resolution unit B14d. If the name resolution request target node is an encrypted communication node, the DNS response/query transmission/reception unit B11d receives encrypted communication path setting information to be used for communication with the node. The DNS response/query transmission/reception unit B11d creates a DNS response message on the basis of the pieces of information received from the name resolution unit B12a and communication method resolution unit B14d and transmits the DNS response message to the client node A1d.

Upon receiving a name resolution request, the name resolution unit B12a executes name resolution by looking up the address resolution database B13a and transfers the name resolution result to the DNS

response/query transmission/reception unit B11d.

Domain names and corresponding IP addresses are registered in the address resolution database B13a.

Upon receiving the name resolution result from
5 the DNS response/query transmission/reception unit B11d,
the communication method resolution unit B14d resolves
the type of the communication partner by looking up the
CUG setting database B15d. If the communication partner
is an encrypted communication target node, the
10 communication method resolution unit B14d also resolves
encrypted communication path setting information to be
used for communication with the node. A detailed
example of the resolution operation will be described
later. After this processing, the communication method
15 resolution unit B14d transfers the resolution result to
the DNS response/query transmission/reception unit B11d.

The identification information of each
encrypted communication target node is registered in the
CUG setting database B15d. Encrypted communication path
20 setting information to be used for communication can
also be registered. These pieces of information can be
registered as indicated by a table 201 shown in Fig. 2.
The identification information of each encrypted
communication target node may be registered in the CUG
25 setting database B15d in correspondence with each client
node or each group of client nodes. With this
registration method, such control is possible that even

with a communication method resolution request for the same node, the communication method changes depending on the client node. For example, when the type of a certain node is resolved as an encrypted communication target node for a specific client node, encrypted communication from the specific client node can be permitted.

Fig. 6 shows a detailed example of the CUG setting database B15d. The CUG setting database B15d shown in Fig. 6 includes the following two kinds of tables (1) and (2) in which the identification information of encrypted communication target nodes and encrypted communication path setting information to be used for communication are registered for each client node or each group of client nodes.

(1) A table in which the identification information of encrypted communication target nodes and encrypted communication path setting information to be used for communication are registered. Tables 502 to 504 are of this type. In the tables 502 to 504, the identification information of each encrypted communication target node is registered in the form of a domain name. As encrypted communication path setting information (encrypted communication path specifications), communication protocols, digital certificate IDs, and encryption algorithms are registered.

(2) A table in which the identification information of client nodes and the identifiers of the tables (1) to be looked up for communication method resolution triggered by reception of a DNS query message from the client nodes are registered. A table 501 is of this type. In the table 501, the identification information of each client node is registered in the form of an IP address. The identifiers of the tables 502 to 504 to be looked up for communication method resolution triggered by reception of a DNS query message from the client nodes with the IP addresses are registered.

A detailed example of the communication method resolution operation when the DNS server B1d holds the CUG setting database B15d shown in Fig. 6 will be described below.

For example, when a DNS query message is received from a client node with an IP address "1.2.3.4", the table 501 is looked up. The first entry that matches the client node identification information (IP address: 1.2.3.4) is checked. On the basis of the registered contents of the first entry, the table with Table ID 1, i.e., the table 502 is looked up. When the domain name as the target of name resolution request of the client node is "kojima.jinji.nec.com", the first entry of the table 502 is checked. The communication method is resolved to [communication node type:

encrypted communication target node, communication
protocol: SSL, digital certificate ID: jinji.nec.com,
encryption algorithm: 3DES].

When a client node with an IP address
5 "5.6.7.8" requests name resolution of
"kojima.jinji.nec.com" in the same way as described
above, the second entry of the table 503 is finally
checked. The communication method is resolved to be
different from the above example, i.e., to
10 [communication node type: encrypted communication target
node, communication protocol: IPsec, digital certificate
ID: soumu-jinji.nec.com, encryption algorithm: AES].

When a client node with an IP address
"133.11.23.24" requests name resolution of
15 "kojima.jinji.nec.com" in the same way as described
above, the table 504 is looked up. However, no entry
matching "kojima.jinji.nec.com" is registered in the
table 504. Hence, the communication method is resolved
to [communication node type: normal communication target
20 node].

The operations of the client node Ald and DNS
server Bld of this embodiment will be described next.

The operation of the client node Ald will be
described first. Operations of the client node Ald are
25 roughly classified into an operation executed when the
application Allx issues a name resolution request for
the domain name of a communication partner and an

operation executed when a data packet is transmitted to the communication partner. The latter operation is the same as that described in the first embodiment of the present invention, and a description thereof will be omitted. The operation in requesting name resolution is different from that of the first embodiment of the present invention in the operation after receiving a DNS response message from the external DNS server (from step S104 in Fig. 4). The operation after receiving a DNS response message from the external DNS server will be described below.

Upon receiving a DNS response message from the DNS server B1d, the DNS query/response transmission/reception unit A121d creates a new DNS response message on the basis of the name resolution result contained in the received DNS response message, and transmits the DNS response message to the application A11x. The DNS query/response transmission/reception unit A121d also checks the node type information of the communication partner contained in the message. If the communication partner is an encrypted communication target node, the DNS query/response transmission/reception unit A121d transfers, to the encrypted communication path setting unit A123d, the name resolution result of the communication partner contained in the DNS response message received from the DNS server B1d and encrypted

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communication path setting information to be used for
communication with the communication partner. The
encrypted communication path setting unit A123d
registers, in the encrypted communication path setting
5 table A142a, the information of the encrypted
communication target node in accordance with the same
procedures as in the operation of the first embodiment
of the present invention.

Upon receiving the DNS response message, the
10 application A11x designates, as the destination address,
the address contained in the name resolution result
given by the DNS response message and transmits a data
packet.

The operation of the DNS server B1d will be
15 described next. Upon receiving a DNS query message from
the client node A1d, the DNS server B1d executes name
resolution of the communication partner of the client
node A1d. The DNS server B1d also resolves the
communication method to be employed for communication
20 between the client node A1d and the communication
partner. More specifically, the DNS server B1d resolves
the node type of the communication partner, and if the
node is an encrypted communication target node for the
client node A1d, resolves encrypted communication path
25 setting information to be used for communication with
the node. The DNS server B1d transmits the resolution
result to the client node A1d by a DNS response message.

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The effects of this embodiment will be described next. In this embodiment, the DNS server Bld unitarily manages the identification information of encrypted communication target nodes and encrypted communication path setting information to be used for communication. For this reason, individual client nodes need not set and hold the information. Especially in communication executed by a group including a plurality of client nodes, even when encrypted communication path setting information or the like is changed, one change in the DNS server Bld suffices. Hence, the information on the DNS server Bld can efficiently be shared in the group.

The third embodiment of the present invention will be described next with reference to the accompanying drawings.

Referring to Fig. 7, the third embodiment of the present invention is different from the first embodiment of the present invention in that a client node Alg includes neither DNS Proxy unit nor communication encryption module, and these modules are included in an external communication encryption node Fla. More specifically, this embodiment is different from the first embodiment of the present invention mainly in the following two points.

(1) The node type (i.e., whether the communication partner is an encrypted communication

target node or normal communication target node) of the communication partner of the client node Alg and encrypted communication path setting information to be used for communication with the communication partner
5 when the communication partner is an encrypted communication target node are resolved by the communication encryption node Fla.

(2) When the client node Alg communicates with an encrypted communication target node, communication
10 encryption processing is executed by the communication encryption node Fla.

The third embodiment will be described below with the focus on different points from the first embodiment of the present invention.

15 The client node Alg will be described first. The client node Alg includes an application A11x and a data transmission/reception unit A14x. The application A11x and data transmission/reception unit A14x have the same functions as those described in the first
20 embodiment of the present invention. However, the data transmission/reception unit A14x has neither communication encryption unit nor encrypted communication path setting table, unlike the first embodiment of the present invention. In this
25 embodiment, the address of the communication encryption node Fla is set in the client node Alg as a DNS server.

The communication encryption node Fla will be

described next. The communication encryption node F1a includes a DNS Proxy unit DNS Proxy unit F12a and the data transmission/reception unit A14x.

The DNS Proxy unit F12a will be described first. The DNS Proxy unit F12a has the same arrangement as that of the DNS Proxy unit A12a of the first embodiment of the present invention. The DNS Proxy unit F12a has a function of determining the node type of the communication partner of the client node Alg and registering encrypted communication path setting information in an encrypted communication path setting table F142a. The DNS Proxy unit F12a is different from the DNS Proxy unit A12a of the first embodiment of the present invention in the following two points.

(1) The DNS Proxy unit F12a executes reception processing of a name resolution request from the external client node Alg.

(2) When the communication partner of the client node Alg is an encrypted communication target node, the DNS Proxy unit F12a converts the IP address of the communication partner into an intercept address and sends it as a name resolution result in response to a name resolution request for the communication partner. An intercept address indicates an address that allows the communication encryption node F1a to intercept a transmission data packet of the client node Alg when the address is designated as the destination address of the

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data packet. A detailed example is the IP address of the communication encryption node F1a itself. This will be described later in detail. As will be described later, the IP address of the communication partner is
5 directly used according to circumstances. In that case, the IP address of the communication partner is sent as a name resolution result even after the IP address of the communication partner is converted into the intercept address.

10 Each module included in the DNS Proxy unit F12a will be described below.

 A DNS query/response transmission/reception unit F121a has the same functions as those of the DNS query/response transmission/reception unit A121a of the
15 first embodiment of the present invention except that a DNS response/query message is transmitted/received to/from the external client node A1g.

 A communication method resolution unit F122a has the same functions as those of the communication
20 method resolution unit A122a of the first embodiment of the present invention.

 An encrypted communication path setting unit F123a is different from the encrypted communication path setting unit A123a of the first embodiment of the
25 present invention in that the IP address of the communication partner contained in a name resolution result received from the communication method resolution

unit F122a is mapped to an intercept address. A detailed operation will be described below.

Upon receiving a name resolution result from the communication method resolution unit F122a, the encrypted communication path setting unit F123a selects an intercept address that is not used in any other communication session by looking up the encrypted communication path setting table F142a, maps the IP address of the communication partner of the client node Alg, which is contained in the name resolution result, to the intercept address, and sends the intercept address to the DNS query/response transmission/reception unit F121a. The encrypted communication path setting unit F123a also registers, in the encrypted communication path setting table F142a, the correspondence between the selected intercept address, the name resolution result received from the communication method resolution unit F122a, and encrypted communication path setting information to be used for communication with the communication partner of the client node Alg.

The same information as in the DNS server address setting table A124a of the first embodiment of the present invention is registered in a DNS server address setting table A124a.

In a CUG setting database F125a, the identification information of encrypted communication

target nodes (CUG participant nodes) and encrypted communication path setting information to be used for communication are registered, as in the CUG setting table A125a of the first embodiment of the present invention. The CUG setting database F125a is looked up by the communication method resolution unit F122a to determine the type of the communication partner of the client node A1g. In the CUG setting database F125a, node identification information and encrypted communication path setting information may be registered for each encrypted communication target node, as in the CUG setting table A125a of the first embodiment of the present invention. Alternatively, a plurality of encrypted communication target nodes may be put into a group, and node identification information and encrypted communication path setting information can be registered for each group. In the CUG setting database F125a, the identification information of each encrypted communication target node and encrypted communication path setting information to be used for communication may be registered for each client node or each group of client nodes, as in the CUG setting database B15d of the second embodiment of the present invention. In this case, the pieces of information are registered in a form shown in, e.g., Fig. 6.

The arrangement of the DNS Proxy unit F12a has been described above.

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An communication encryption unit F141a and encrypted communication path setting table F142a of the data transmission/reception unit A14x will be described next.

5 The name resolution result (e.g., the IP address of the communication partner) of the communication partner of the client node Alg, encrypted communication path setting information to be used for communication with the communication partner, and
10 corresponding intercept address are registered in the encrypted communication path setting table F142a. The encrypted communication path setting table F142a is looked up by the encrypted communication path setting unit F123a to map the IP address of the communication
15 partner of the client node Alg to an intercept address and by the communication encryption unit F141a to execute communication encryption processing. Fig. 8 shows an example of the encrypted communication path setting table F142a. In an encrypted communication path
20 setting table 601 shown in Fig. 8, the IP address and domain name of the communication partner of the client node Alg are registered as information contained in the name resolution result for each corresponding intercept address.

25 The communication encryption unit F141a encrypts a data packet transmitted from the client node A1 to an encrypted communication target node. Detailed

procedures of the encryption processing will be described below.

When the client node Alg communicates with an encrypted communication target node, an intercept address is designated as the destination address of a data packet transmitted from the client node Alg (because an intercept address is sent from the DNS Proxy unit F12a as a name resolution result in response to a name resolution request for an encrypted communication target node). All data packets are intercepted by the communication encryption node F1a. The intercepted data packet is transferred to the communication encryption unit F141a. The communication encryption unit F141a grasps the IP address of the communication partner corresponding to the destination intercept address and encrypted communication path setting information to be used for communication with the communication partner by looking up the encrypted communication path setting table F142a on the basis of the destination address of the intercepted data packet. The communication encryption unit F141a encrypts the intercepted data packet in accordance with the grasped encrypted communication path setting information and transmits the data packet to the communication partner of the client node Alg.

A detailed example of the above-described communication encryption processing will be described

below. As a detailed example, a case wherein the data transmission/reception unit A14x holds a table 601 shown in Fig. 8 as the encrypted communication path setting table F142a is assumed. An example will be described in which the communication encryption node F1a intercepts a data packet with a destination address "fe80::3090" transmitted from the client node Alg.

First, the communication encryption unit F141a looks up the encrypted communication path setting table F142a and grasps an entry corresponding to the destination address "fe80::3090". In this case, the second entry of the table 601 corresponds to the destination address. The communication encryption unit F141a consequently acquires "communication protocol: SSL, digital certificate ID: 10, encryption algorithm: 3DES" as encrypted communication path setting information to be used for communication. The communication encryption unit F141a rewrites the destination address of the intercepted data packet from "fe80::3090" to "aa91::1001" as the IP address of the communication partner, encrypts the data packet by the 3DES algorithm in accordance with the encrypted communication path setting information, and transmits the data packet to the communication partner by the SSL protocol.

Detailed procedures of the communication encryption processing by the communication encryption

unit F141a have been described above.

IP addresses usable as an intercept address will be described next.

For example, the following two addresses can
5 be used as an intercept address.

(1) The IP address of the communication encryption node Fla itself

(2) An arbitrary address outside the address scope of a subnet to which the client node Alg belongs.

10 When the IP address (1) of the communication encryption node Fla itself is used as an intercept address, the communication encryption node Fla must be assigned a plurality of IP addresses. The reason will be described. The communication encryption node Fla
15 identifies the communication partner of the client node Alg on the basis of the intercept address designated as the destination address of a data packet transmitted from the client node Alg. Hence, if a plurality of communication partners or client nodes are assumed to be
20 used, a plurality of IP addresses must selectively be used. The larger the number of IP addresses is, the larger the number of usable communication partners or client nodes is. For this reason, it is convenient that IP addresses should be assigned to the communication
25 encryption node Fla as much as possible.

When an arbitrary address (2) outside the address scope of a subnet to which the client node Alg

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belongs is used as an intercept address, the
communication encryption node Fla must be the default
gateway of the client node Alg. When the client node
Alg transmits a data packet to an address outside the
5 address scope of the subnet to which the client node Alg
belongs, the data packet passes through the
communication encryption node Fla serving as the default
gateway for routing processing. If the communication
partner of the client node Alg is present outside the
10 subnet to which the client node Alg belongs, the IP
address of the communication partner can directly be
used as an intercept address.

The operation of the communication encryption
node Fla after the client node Alg requests name
15 resolution of the communication partner until
communication with the communication partner starts in
this embodiment will be described next.

Operations of the communication encryption
node Fla are classified into an operation upon receiving
20 a DNS query from the client node Alg and an operation
upon intercepting a data packet transmitted from the
client node Alg.

The operation upon receiving a DNS query from
the client node Alg will be described with reference to
25 Fig. 4.

When the communication encryption node Fla
receives a DNS query message from the client node Alg

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(step S101), the DNS query/response
transmission/reception unit F121a transmits the received
DNS query message to an external DNS server Bla
registered in the DNS server address setting table F124a
5 (step S102) and receives a DNS response message from the
DNS server Bla as a response (step S103).

The DNS query/response transmission/reception
unit F121a extracts a name resolution result from the
received DNS response message and transfers the name
10 resolution result to the communication method resolution
unit F122a.

The communication method resolution unit F122a
determines the node type (encrypted communication target
node or normal communication target node) of the
15 communication partner by looking up the CUG setting
database F125a on the basis of the received name
resolution result (step S104). The subsequent operation
changes depending on the type of the communication
partner.

20 A case wherein the communication partner is a
normal communication target node will be described
first. In this case, the communication method
resolution unit F122a sends the determination result to
the DNS query/response transmission/reception unit
25 F121a. The DNS query/response transmission/reception
unit F121a newly creates a DNS response message on the
basis of the name resolution result received from the

DNS server B1a and transmits the DNS response message to the client node Alg (step S106).

Upon receiving the DNS response message, the client node Alg transmits a data packet by setting, as
5 the destination address, the IP address of the communication partner given by the received DNS response message. In this case, the data packet transmitted from the client node Alg is transmitted directly to the communication partner without intervention of the
10 communication encryption node F1a so that normal communication with the communication partner is executed.

A case wherein the communication partner is an encrypted communication target node will be described
15 next. In this case, the communication method resolution unit F122a grasps, from the CUG setting database F125a, encrypted communication path setting information to be used for communication with the communication partner of the client node Alg and transfers the encrypted
20 communication path setting information to the encrypted communication path setting unit F123a together with the name resolution result received from the DNS query/response transmission/reception unit F121a.

Upon receiving the name resolution result and
25 encrypted communication path setting information, the encrypted communication path setting unit F123a maps the IP address of the communication partner of the client

node Alg to an intercept address that is not used in any other communication session by looking up the encrypted communication path setting table F142a. The encrypted communication path setting unit F123a sends the mapped
5 intercept address to the communication method resolution unit F122a. The encrypted communication path setting unit F123a also registers, in the encrypted communication path setting table F142a, the correspondence between the intercept address, the name
10 resolution result received from the communication method resolution unit F122a, and the encrypted communication path setting information to be used for communication with the communication partner (step S105).

The communication method resolution unit F122a
15 transfers the intercept address received from the encrypted communication path setting unit F123a to the DNS query/response transmission/reception unit F121a.

Upon receiving the intercept address from the communication method resolution unit F122a, the DNS
20 query/response transmission/reception unit F121a creates a DNS response message by rewriting the address of the communication partner contained in the name resolution result received from the DNS server Bla to the intercept address and transmits the DNS response message to the
25 client node Alg. That is, the client node Alg receives the intercept address selected by the encrypted communication path setting unit F123a as the name

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resolution result for the domain name of the
communication partner (step S106).

Upon receiving the DNS response message, the
client node Alg designates the intercept address
5 contained in the name resolution result as the
destination address and transmits the data packet. As a
result, the data packet is intercepted by the
communication encryption node Fla and encrypted.

The operation when the communication
10 encryption node Fla receives a DNS query from the client
node Alg has been described above.

The operation when the communication
encryption node Fla intercepts a data packet transmitted
from the client node Alg will be described next.

15 When the communication encryption node Fla
intercepts a data packet transmitted from the client
node Alg, the communication encryption unit F141a
acquires the IP address of the communication partner and
encrypted communication path setting information to be
20 used for communication with the communication partner of
the client node Alg by looking up the encrypted
communication path setting table F142a on the basis of
the destination address (an intercept address is
designated) of the data packet. Using the acquired
25 encrypted communication path setting information, the
communication encryption unit F141a causes an
encryption/decryption processing unit F1411a to encrypt

the intercepted data packet, sets the IP address of the communication partner to the destination address of the data packet, and transmits the data packet to the communication partner.

5 In the above description, the node type of the communication partner, and if the communication partner is an encrypted communication target node, encrypted communication path setting information to be used for communication with the communication partner are
10 resolved in the communication encryption node Fla. This embodiment may employ an arrangement for causing the DNS server Bla to execute the resolution, as in the second embodiment of the present invention. In this case, the DNS server Bla has the same arrangement as that of the
15 DNS server Blb shown in Fig. 5 described in the second embodiment, and the communication encryption node Fla has the arrangement shown in Fig. 9. In this case, the DNS query/response transmission/reception unit F121a has the same functions as those of the DNS query/response
20 transmission/reception unit A121d of the second embodiment of the present invention.

A communication encryption node Fla shown in Fig. 9 comprises the data transmission/reception unit A14x provided in the kernel unit, and a name resolution
25 proxy unit F12a which relays a name resolution query transmitted from the application on a client node (not shown) to the name resolution server (not shown) to

resolve the IP address of another node apparatus and a name resolution response as the response to the query.

The data transmission/reception unit A14x comprises the encrypted communication path setting table F142a which holds the correspondence between a communication partner IP address, an intercept address, and encrypted communication path setting information, and the communication encryption unit F141a which receives a data packet transmitted from the application and having the intercept address set as the destination address, reads out, from the encrypted communication path setting table F142a, encrypted communication path setting information and a communication partner IP address corresponding to the intercept address set as the destination address of the data packet, and encrypts the data packet having the readout communication partner IP address set as the destination address in accordance with the readout encrypted communication path setting information and transmits the data packet.

The name resolution server (not shown) comprises, in addition to the functions associated with name resolution, a setting table which holds the correspondence between encrypted communication path setting information and a domain name condition to specify an encrypted communication target node, a communication method resolution unit which determines whether the domain name of the other node apparatus

contained in a name resolution query or name resolution response matches any one of domain name conditions held in the setting table, and a name resolution response/query transmission/reception unit which adds
5 encrypted communication path setting information corresponding to the matched domain name condition to the name resolution response and transmits it.

The name resolution proxy unit F12a comprises the encrypted communication path setting unit F123a
10 which, upon receiving the name resolution response with the encrypted communication path setting information from the name resolution server, registers, in the encrypted communication path setting table F142a, the correspondence between the encrypted communication path
15 setting information, the IP address of the other node apparatus resolved by the name resolution response, and the intercept address that is not used in any other communication session, and the DNS query/response transmission/reception unit F121a which transmits, to
20 the application as the name resolution response, an intercept address corresponding to the IP address of the other node apparatus contained in the name resolution response received from the name resolution server.

The effects of this embodiment will be
25 described below. In this embodiment, communication partner type determination and communication encryption processing for an encrypted communication target node

are done not in each client node but in an external communication encryption node. Hence, the system can be used even when no communication encryption module can be installed in the client node. In addition, the load on the client node is light as compared to a case wherein communication partner type determination and communication encryption processing for an encrypted communication target node are executed in the client node. Hence, the system can be used even in a node (e.g., a cellular phone and PDA) with a relatively low calculation capability.

The embodiments of the present invention have been described above. The present invention is not limited to the above-described embodiments, and various changes and modifications can be made. The functions of the client node apparatus, communication encryption node apparatus, and name resolution server of the present invention can be implemented by hardware or by a computer and program. The program is recorded on a computer-readable recording medium such as a magnetic disk and semiconductor memory and read out by a computer in activating it. The computer is caused to function as the client node apparatus, communication encryption node apparatus, and name resolution server of the above-described embodiments by controlling the operation of the computer.